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RAPTOR RESEARCH

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SUCCESSFUL BREEDING OF JUVENILE PRAIRIE FALCONS IN NORTHEAST COLORADO

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The occurrence of raptors in juvenile plumage as part of a breeding pair is well documented (Hickey 1942, Webster 1944, Goskin 1952, Hurrell 1971, and Porter and White 1973). The magnitude of this occurrence on a population basis in raptors is largely unknown. Generally, the "floating population," nonbreeding adults, in a healthy population would be recruited more readily than juveniles. One of the signs of Peregrine Falcon (*Falco peregrinus*) decline was that juveniles began to appear frequently as part of a pair (J. Craig pers. comm.).

During May and June 1976 and 1977 I trapped, color marked, and banded with aluminum leg bands 48 breeding Prairie Falcons (*F. mexicanus*) at their eyries (31 ♀ ♀ and 17 ♂ ♂). Seven females were in juvenile plumage, one in 1976 and six in 1977. All seven hatched and fledged young. Six of the juveniles made up 33 percent of the females trapped in 1977 (18 total) and fledged 21 percent of the fledglings (91 total). One marked adult was replaced by a young female. Three others were part of a pair where single adults were observed in 1976. Twenty-eight eyries were studied in both years, and juvenile females constituted 50 percent of the *known* recruitment.

Henny et al. (1970) have published a method for determining poulation parameters by using structural models. Several special case models are given, and the age of first breeding is used in several when selecting the appropriate model. Medium-sized raptors are generally thought to breed at two years of age. Enderson (1969) estimates mortality rates for juvenile and adult Prairie Falcons to be 74 and 25 percent respectively. Using these mortality rates and the model for age at first breeding (one year), the productivity required to maintain a stable population is 1.92 fledged per nesting attempts. In contrast, if age at first breeding is two years the productivity required would be 2.56.

The number of breeding pairs of Prairie Falcons in Weld County is little changed from that estimated and observed in the past. The mean fledging success of this population from 1962 to 1969 was 1.99 fledged per nesting attempt (Stoddart and Olendorff pers. comm.). The appearance of so many breeding juveniles may be more a result of a reduced floating population or increased survival of juveniles (less severe than normal winter in 1976–77) than that of a declining population. The floating population at normal levels may also prevent juveniles from being readily recruited. Thus, juvenile Prairie Falcons appear to have the capacity to breed at one year of age and contribute significantly to the overall reproductive success of the population.

Acknowledgments

The Colorado Division of Wildlife and the National Audubon Society provided funds for this project. My thanks to Mr. John W. Stoddart, Mr. Jerry R. Craig, Dr. Clayton M. White, Dr. C. E. Knoder, Mr. John M. Anderson, Mr. Alan R. Harmata,

Mr. James McKinley, and Mrs. P. A. Platt, who have contributed significantly to the success of the project.

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HUNTING TECHNIQUES AND PREDATORY EFFICIENCY OF NESTING RED-TAILED HAWKS

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Abstract

The hunting techniques and predatory efficiency of three pairs of nesting Red-tailed Hawk (*Buteo jamaicensis*) were studied for 545.5 hours, from June 1975 through September 1975. Four hunting techniques and 169 strikes were observed. The three pairs of hawks were 78.8 percent successful in their attempts at prey. There were, however, statistically significant differences between the observed hunting techniques.

Introduction

The literature is replete with feeding observations on Red-tailed Hawks, but these citings usually are one- or two-paragraph accounts of a single strike. Quantitative data have been gathered by English (1934), Errington (1930, 1932, 1933, 1935), and Errington and Breckenridge (1938). However, the majority of these data dealt with stomach analysis, pellet examination, and prey remain analysis as a basis for recording the feeding habits of Red-tails. Wakeley (1974) studied the Ferruginous Hawk (*B. regalis*) and reported the first predatory efficiency data in the genus *Buteo*. The data presented herein forms the first known report for the Red-tailed Hawk (*Buteo jamaicensis*).

Methods and Materials

Data were gathered from elevated and ground blinds and by radio tracking one female hawk fitted with a 55g transmitter. Each of three nests was observed for equal amounts of time during the study; each nest was observed throughout all daylight hours, but not necessarily all day on any one day. All observations were aided by a pair of 7X, 35 binoculars and a 15-60 power spotting scope. The one radio-tagged Red-tail was tracked with a hand-held receiver and three-element Yagi antenna.

Clay County, South Dakota, is located in the southeastern corner of the state. The nesting areas lie along the lower part of the Vermillion River Basin. Dunstan and Harrell (1973) used the same area for their study of the Great Horned Owl (*Bubo virginianus*). They observed that the area was used primarily for agricultural crops with corn, soybeans, and alfalfa the major crops grown. The remainder of the land was allotted to pastures, feeder lots, river beds, and fallow areas. These patterns of land use remained the same through 1975 when this study was conducted.

Results and Discussion

All the adult hawks hunted over similar habitats. Edges between riverbeds and soybean fields, dry riverbeds, corn fields, and alfalfa and wheat fields were hunted most extensively. The hawks preferred short vegetation, less than 10 cm, and shifted their hunting ranges in response to agricultural harvesting practices. Roadside ditches, fallow areas, and farm lanes were also used as hunting areas. The utilization of short vegetation areas was probably due to prey vulnerability in the harvested areas rather than to a reduction of the prey base in the higher vegetation areas.

Hunting Techniques

Four hunting techniques were used by the hawks during this study. To categorize each technique, the hawk's position, prior to initiation of a strike, was recorded. The four techniques were: (a) strike from a perch, (b) strike by direct flight, (c) strike from soaring flight, (d) strike by a combination of direct flight and soaring. One hundred sixty-nine strikes, using these four techniques, were observed.

Strike from a Perch. Trees, fenceposts, telephone poles, highline supports, and alfalfa stacks were used as perches from which strikes were initiated. The distance between a hawk and a prey varied from 1 to 14 m. The distance of 15 m was arbitrarily established, at the beginning of the study, as the breaking point for strike types "a" and "b". In this technique, the hawk used one or two wingbeats to become airborne then glided the short distance to strike at the prey. The distance varied depending upon the elevation of the perch. The hawk, when using fenceposts, appeared to step off the post and drop to its prey without the use of wingbeats to become airborne.

Strike by Direct Flight. A strike initiated from a perch but requiring flapping to maintain an airborne condition was termed by a strike by direct flight. The distance between the perched hawk and its prey varied from 15 to 150 m.

Strike from Soaring Flight. Strikes by a soaring hawk varied in the altitude from which the strike was initiated and involved a closed-wing dive on the prey. A short distance before impact, back-pedaling with wings spread, the hawk struck the prey. All strikes initiated from this position were directed at larger and conspicuous prey.

Direct Flight/Soar Strikes. Occasionally, a strike was initiated from a soar, and when prey was detected, the hawk soared out of sight and then used flapping flight

to fly around vegetation (which served as camouflage) to execute a "sneak attack" from the blind side. This technique was not used often and presented a problem to the hawk. The potential prey often moved, and the hawk had to make a rapid scan of the area when it reappeared from behind the vegetation. The prey's movement while the hawk was out of sight often put the hawk out of position for a successful strike. Thus, such strikes were largely unsuccessful.

Predatory Efficiency

Predation efficiency is the ratio of successful strikes to total strikes observed, with unknown outcomes omitted from the calculations. Overall, the adult Red-tails of this study were very efficient predators. Chi square tests, modeled after Cochran and Cox (1957), demonstrated no significant differences in the predatory efficiency among the adults of the three nests. Table 1 summarizes the efficiency for the adult hawks of the three nests observed. There was a slight decrease in efficiency as the number of nestlings increased. Predatory efficiency varied with the four hunting techniques observed (table 2). Hunting from a perch was the most commonly used technique and the most successful. Collopy (1973) and Ueoka and Koplin (1973) observed similar results with American Kestrels (*Falco sparverius*) and Ospreys (*Pandion haliaetus*), respectively. Wakeley (1974), on the other hand, found strikes from a perch were unsuccessful. The heavy use of this technique in our study was probably due to the short vegetation which made prey more visible and the strike distance shorter. The result was an element of surprise in favor of the hawks. The direct-flight technique was used successfully throughout the study and as in the perch technique the element of surprise was probably the greatest contributing factor. Soaring accounted for few strikes and a very low success ratio. Soaring hawks missed their prey because of the alert, fast reactions of the prey species, generally rabbits (*Sylvilagus floridanus*). The direct flight/soar technique was used on larger, alert prey, i.e., the fox squirrel (*Sciurus niger*), and was for the most part unsuccessful. The alert posture maintained by the squirrels, while the hawks hunted in the area, resulted in the low success ratio.

Acknowledgments

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Table 1. Comparative strike data for nest areas 1, 2, and 3 for the entire study.

Nest area	Number of fledglings	Total strikes	Successful strikes	Unknown outcomes	Percent success*
1	1	94	61	17	79.2
2	2	38	21	9	72.4
3	0	37	26	6	83.3
Totals	3	169	108	32	78.3

*Percent success: $\frac{\text{Successful strikes}}{\text{Total strikes} - \text{Unknown outcomes}}$

Table 2. Strike type and success during the entire study.

Technique	Total Strikes	Successful Strikes	Unknown Outcomes	Percent success	
Perch	111	76	21	84.4	NS
Direct flight	47	30	10	81.1	**
Soar	7	1	1	16.7	NS ** ***
Soar/flight	4	1	0	25.0	***
Totals	169	108	32	78.8	

NS Not significant
** Significant at the .01 level.
*** Significant at the .05 level.

OPPORTUNISTIC HUNTING OF A MARSH HAWK ON A BOMBING RANGE

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On 25 February 1977 we visited a U.S. Navy bombing range in Noxubee County, Mississippi, during bombing practice by Navy TA-4 jets. The range, which is 1 mile long and 3000 feet wide, was once pine forest, but in 1973 the forest was cut and debris from the harvest piled into windrows. Much of the cleared area now has a cover dominated by *Andropogon*. A series of concentric circles formed by old tires form a target in the center of the range. The range is surrounded by pine forest.

During bombing runs, from approximately 0945 to 1015 and 1245 to 1315, we observed a female Marsh Hawk (*Circus cyaneus*) hunting within the target range and specifically near the target site. During each bombing run approximately one jet per minute bombed the target with a 25-pound practice bomb from an altitude of approximately 1800 feet above the ground. The practice bombs exploded with a noise which seemed to us about as loud as a 12-gauge shotgun, gave a brief flash, and released a trail of smoke which allowed observers to measure the accuracy of the pilots. The greatest noise associated with the activity was from the jets. We measured this from approximately 1500 feet to the side of the target and found it to vary between 80 and 87 decibels. Throughout the bombing the Marsh Hawk continued hunting from a height of 15-20 feet—even when a bomb exploded within 200 feet. Between the bombing runs the Marsh Hawk hunted over a larger area of the range, but during the bombing her activities seemed to be focused more on the target area.

On at least one occasion she dropped to the ground out of our sight and may have been successful at prey capture. On another occasion she made an unsuccessful attack on a small bird. We feel that this Marsh Hawk was taking small mammals and possibly birds that were flushed from cover by the bombing. Navy personnel indicated that the bombing range may be used for similar practice up to 6 days per week. This Marsh Hawk had certainly become acclimated to the loud and unusual human activities in the area.

We acknowledge and appreciate the hospitality of the Navy during our visit.

RAPTOR NESTS AS A HABITAT FOR INVERTEBRATES: A REVIEW

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Abstract

Invertebrates in raptor nests may be classified into three major groups: parasite fauna, animal saprovores, and humus fauna. The parasite fauna includes raptor and prey parasites and their corresponding parasites and predators. The animal saprovore fauna includes the invertebrates associated with the decomposition of such material as carrion, excreta, pellets, and molted feathers. The humus fauna includes invertebrates associated with decomposition of nest material such as litter and wood.

Introduction

Raptors nest in a wide variety of locations below, on, and above the ground level. Occasionally raptors share their nests with other birds, e.g., the Great Horned Owl (*Bubo virginianus*) and the Bald Eagle (*Haliaeetus leucocephalus*) nest together (Austing and Holt 1966); the Screech Owl (*Otus asio*) nests with the Elf Owl (*Micrathene whitneyi*), and woodpeckers, the American Kestrel (*Falco sparverius*) and the Purple Martin (*Progne subis*) (Grossman and Hamlet 1964, Sumner 1933, Wilson 1925). Small birds of several species may nest in Osprey (*Pandion haliaetus*) nests (Zarn 1974). However, nearly every raptor shares its nest with many invertebrates. Referring only to mites in bird nest-box debris, Herman (1936) stated that "an estimate of billions in each nest seems conservative." Actually, according to our work, "thousands" seems to be a more accurate estimate.

Nests of birds and mammals are a habitat for many invertebrates including some domestic pests and arthropods of medical importance. Raptor nest fauna may be divided into three main groups: parasite fauna, animal saprovores, and humus fauna. Parasite fauna of raptor nests includes raptor and prey parasites and their parasites and predators. The animal saprovores include the invertebrates associated with the decomposition of such material as carrion, excreta, pellets, and molted feathers. The humus fauna includes invertebrates associated with nest material such as litter, soil, and wood.

Bird Nest Community Studies

There have been few studies of the entire invertebrate community within nests. Most investigators have only sampled one animal group from a nest, such as fleas or beetles. Others have sampled old nests, without knowing which bird species built or used the nest. Consequently, data on nest invertebrates is scattered in the literature and incomplete.

A few extensive studies of bird nest fauna have been made (Nordberg 1936, Wood-

roffe 1953). Woodroffe and Southgate (1951) studied nests of the House Sparrow (*Passer domesticus*), Starling (*Sturnus vulgaris*) and Robin (*Erithacus rubecula*). In these nests, there was a definite succession of invertebrates. Ectoparasites of the bird dominated during initial nest construction and occupation. After the nest was deserted, scavenging invertebrates were dominant as the feather debris and excreta passed through various stages of decomposition. The final stage of decomposition of nest material was dominated by humus fauna. If the nest was used as a winter roost and reused the next year, then it acted as a refugium, and the scavenging fauna persisted. Open, exposed nests decomposed faster and the scavenging stage was reduced or absent. Differences in the fauna of nests of different bird species were correlated with differences in the composition of the nests.

The successional pattern was not consistent for all birds' nests. Freitag and Ryder (1973) studied Ringbilled Gull (*Larus delawarensis*) nests and found almost no ectoparasites. Saprophagous mite populations, however, peaked after gull egg-laying while predatory mite populations peaked at or after egg-hatching (Freitag et al. 1974). Arthropod numbers averaged 302 per small nest and 876 per large nest (Ryder and Freitag 1974).

Nests may be regarded as habitat islands, and colonization of nests may occur by many means. Some invertebrates may crawl or fly directly to the nest. Considerable numbers are carried into the nest with nesting material. Parasites may be brought to the nest by the bird; other invertebrates may also reach the nest in this manner (Worth 1975). Raptor nests often contain parasites from vertebrate prey species brought to the nest. In addition, invertebrate prey species brought to the site may escape and colonize the nest (Woodroffe 1953). Chmielewski (1970) demonstrated the possibility of endozoic colonization of nests by mites. He fed astigmatid mites to mice, sparrows, and hens and found that 1-7 percent of the mites survived passage through the alimentary canal.

Raptor Nest Fauna

A summary of arthropod nest fauna for American raptor species is presented in tables 1 and 2 although most of these data are not from North American nests. The work of Hicks (1959, 1962, 1971) is an invaluable guide to the insects known from birds' nests. No such checklist exists for arachnids and other invertebrates.

References to mites and ticks from raptor nests are few and often hidden in the literature. Nordberg (1936) lists mites from several raptor nests, but an error in the work confuses the data from Peregrine Falcon (*Falco peregrinus*) and Eagle Owl (*Bubo bubo*) nests. The importance of mites is shown by our findings. We examined a Screech Owl nest and an American Kestrel nest, and each had a total of over 10,000 mites. Samples from two Great Horned Owl nests have yielded 100 and 83 percent mites.

Nest Parasites

The best known group of invertebrates in nests of raptors in North America are the nidicolous raptor parasites. There have been occasional reports of parasites causing the death of raptor nestlings. Bloodsucking *Protocalliphora* larvae attack nestlings of many birds, including raptors (Hill and Work 1947). The maggots attack the feet, eyes, ears, nares, legs, or anus making entry into the body. Nestling songbirds in nest boxes have been killed, e.g., the Bluebird (*Sialis sialis*) and Tree Swallow (*Iridoprocne*

bicolor) (Mason 1944, Owen 1954). Species with open nests are less susceptible. Sargent (1938) found nests of large hawks to be nearly 100 percent infested but found no evidence of mortality. Buckner and Cole (1971) found a young Red-tailed Hawk (*Buteo jamaicensis*) nearly comatose because of larvae in its ear. The bird recovered after removal of the larvae. White (1963) reported extensive mortality in the young Prairie Falcon (*Falco mexicanus*) from these maggots.

Blackflies have caused mortality in nestling Merlin, *Falco columbarius* (Trimble 1975), and Red-tailed Hawks (Brown and Amadon 1968).

Ticks were stated to cause 65 percent mortality of young Prairie Falcons in Colorado from starvation in their first month (Webster 1944). Williams's (1947) observations did not agree with this, but recently Oliphant et al. (1976) reported the deaths of two nestling Prairie Falcons from a massive infestation of a bird tick *Ornithodoros concanensis.*

The tropical feather mite *Ornithonyssus bursa* is known to have been the cause of the death of a captive European Sparrowhawk (*Accipiter nisus*) (Mites 1963). Ian Newton (pers. comm.) observed deaths of European Sparrowhawk nestlings due to mite attacks. Cooper (1972) noted that mites are more common parasites of hawks than ticks and often infest holding facilities. Chiggers may be present in nests, but we know of no instances where they caused death.

The Mexican chicken bug, *Haematosiphon inodorus* (Cimicidae), is related to the common bedbug and has caused mortality in young Prairie Falcons and Red-tailed Hawks (Platt 1975). Infestations may be quite severe, as shown by Lee (1959) who found 1,778 in a single Barn Owl (*Tyto alba*) nest.

According to Cooper (1972) fleas are not common on birds of prey, and we know of no raptor nestling mortality due to fleas. Fifteen species of fleas have been found in Burrowing Owl (*Speotyto cunicularia*) burrows, but many of them came from previous rodent inhabitants of the burrow. Also, prey brought into the nest is the source of many raptor nest fleas.

Ectoparasitic flies—the louse flies (Hippoboscidae) and *Carnus hemapterus* (Milichiidae) suck blood and may be found on birds and in their nests. Owls are important breeding hosts of hippoboscids, and are favorite winter hosts for species for louse flies that exhibit little host specificity. The plumage of owls offers ideal shelter for ectoparasites, and the beak is poorly adapted for preening (Bequaert 1953). Hippoboscids also may transport phoretic Mallophaga and pseudoscorpions to new hosts and nests (Keirans 1975, Bequaert 1953). We know of no fatal nestling infestations of these flies.

Feather lice and feather mites have been found in raptor nests, but they are generally restricted to the bird's body. They may, however, accidentally fall into the nest when transferring to a new host. These feather parasite obligates normally do little harm to a healthy bird but may increase in numbers and affect a bird already sick and unable to preen.

Parasite Load in Nests. The flying squirrel (*Glaucomys* spp.) is colonial in winter, and parasite levels in nest and resting holes sometimes become so high the hole has to be abandoned (Muul 1968). Data is needed on whether such infestation may also occur in winter colonial roosts of raptors like the Short-eared Owl (*Asio flammeus*). Raptors frequently return to the same nest or build another nearby. Possibly high nest parasite levels make the old nest uncomfortable and unsuitable for reuse in another year.

Predatory Behavior of Ants. Although not parasites, fire ants (*Solenopsis saevissima richteri*) and carpenter ants (*Camponotus* sp.) may kill nestling songbirds (Coon and Fleet 1971, Conner and Lucid 1976). Parker (in press) observed ant predation on Mississippi Kite (*Ictinia misisippiensis*) nestlings. Sykes and Chandler (1974) mentioned a possible predatory ant problem in Everglades Kite (*Rostrhamus sociabilis*) nests. In their view, antproof artificial nesting structures would help eliminate threat.

Natural Biological Control. Next predators and parasites of raptor parasitese are important in determining nest parasite population levels. Staphylinid and histerid beetles present in nests often prey on fleas. Many mites and insect larvae prey on fly larvae: *Nasonia vitripennis,* a wasp parasitic on *Protocalliphora,* has been reported from Long-eared Owl (*Asio otus*) nests (Jellison 1940). The exact trophic interrelationships of many nest species are unknown.

Nest Animal Saprovores

Hide or carpet beetles (Dermestidae) are important in causing the decomposition of animal remains in raptor nests, and Balgooyen (1976) observed them in every American Kestrel nest he studied. He described the symbiotic relationship between beetle and falcon as facultative mutualism. This association would be termed passive protocooperation according to Dindal (1975) since mutualism must be obligatory. The falcon provides the beetle with food and shelter, and the beetle disposes of unused animal debris. However, Rothschild and Clay (1952) note that when the larder beetle (*Dermestes lardarius*) is numerous, it may attack and kill nestling birds. It has sometimes bored into the wing bones of young pigeons and eaten the tissue while the bird was still alive.

Skin beetles (Trogidae) are also important in the role of decomposing animal remains. Most trogids eat hair, feathers, and dried skin and are especially common in owl nests. *Trox tytus* has been found only in Barn Owl nests while *Trox striatus* is known only from owl pellets and nests (Vaurie 1955).

Larvae of the clothes moths (Tineidae) eat hair and are common in birds' nests. We have found both moths and carpet beetles in debris from a porch in Syracuse, N.Y., on which an injured Great Horned Owl was kept. The housing of captive raptors may thus serve as a source of infestation of households with these domestic pests.

Scavenging mites and other insects are also involved in the decomposition of the animal remains in the nest. We have found scavenging mites (fig. 1) to be numerically dominant in an American Kestrel nest. Nordberg (1936), however, found that dermestid and trogid beetles were dominant by volume in nests of Peregrine Falcons and Eagle Owls.

Humus Fauna in Nests

The humus fauna includes invertebrates associated with the decomposition of the nest plant material. Many mites and insects such as springtails (Collembola) are involved in the decomposition of litter, moss, and wood, and are brought to the nest along with that material. In a Screech Owl nest we found the humus fauna, especially Oribatid mites (fig. 2) to be numerically dominant.

Conclusions

There is at present little evidence that arthropods are a very common cause of raptor nestling mortality (Keymer 1972). However, there are few data on raptor nest in-

vertebrates. Many raptors are marginal or endangered species. We need to know what invertebrates may be a source of mortality and how frequently it occurs. After investigating the entire nest community and working out details of trophic relationships, biological control measures against any undesirable invertebrates may be possible. Mason (1944) has suggested use of the parasitic wasp *Nasonia vitripennis* to help control *Protocalliphora*. The problem is complicated because other species of maggots are more preferred hosts. At least, as he recommends, one should avoid cleaning out nest boxes until the wasps have hatched.

With the increased use of artificial nests, we have the capability to more carefully control the nest environment as well as its fauna. Possible addition of an inorganic desiccating agent might make nests less favorable as a habitat for parasites, or kill parasitic occupants. Obviously much more study is needed to elucidate the dynamics of the total community of invertebrates in the nest microhabitat.

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Table 1. Known Raptor Nest Arthropods

Raptor	Total Families	Total Species
Haliaeetus leucocephalus	1	1
Aquila chrysaetos	5	6
Pandion haliaetus	6	20
Falco columbarius	2	5
Falco mexicanus	4	4
Falco peregrinus	15	22
Falco sparverius	6	8
Accipiter cooperii	2	3
Accipiter gentilis	8	28
Accipiter striatus	1	4
Buteo jamaicensis	4	5
Buteo lagopus	6	45
Buteo lineatus	2	3
Buteo platypterus	1	3
Buteo regalis	1	1
Buteo swainsoni	4	5
Buteogallus anthracinus	1	1
Circus cyaneus	4	5
Elanoides forficatus	1	1
Elanus leucurus	1	1
Aegolius acadicus	1	1
Aegolius funereus	12	31
Asio flammeus	8	46
Asio otus	17	40
Bubo virginianus	8	11
Glaucidium brasilianum	1	3
Micrathene whitneyi	1	1
Nyctea scandiaca	2	5
Otus asio	4	6
Speotyto cunicularia	21	39
Strix nebulosa	1	1

Strix occidentalis	1	1
Strix varia	1	2
Surnia ulula	1	1
Tyto alba	22	40
Cathartes aura	3	4
Coragyps atratus	1	2
Gymnogyps californianus	1	1

Table 2. Insect Families Common in Raptor Nests

Diptera	*Coleoptera*	*Hemiptera*	*Siphonaptera*
Calliphoridae	Dermestidae	Cimicidae	Ceratophyllidae
Helomyzidae	Histeridae		Hystrichopsyllidae
Hippoboscidae	Ptiliidae		
Milichiidae	Staphylinidae		
Muscidae	Trogidae		
Simuliidae			

Figure 1. A hypopus, the nonfeeding transport stage of the mite *Lardoglyphus* (Astigmata: Acarina), is phoretic on dermestid beetle larvae. This specimen is a new species found in a Kestrel nest. A description of it is in preparation.

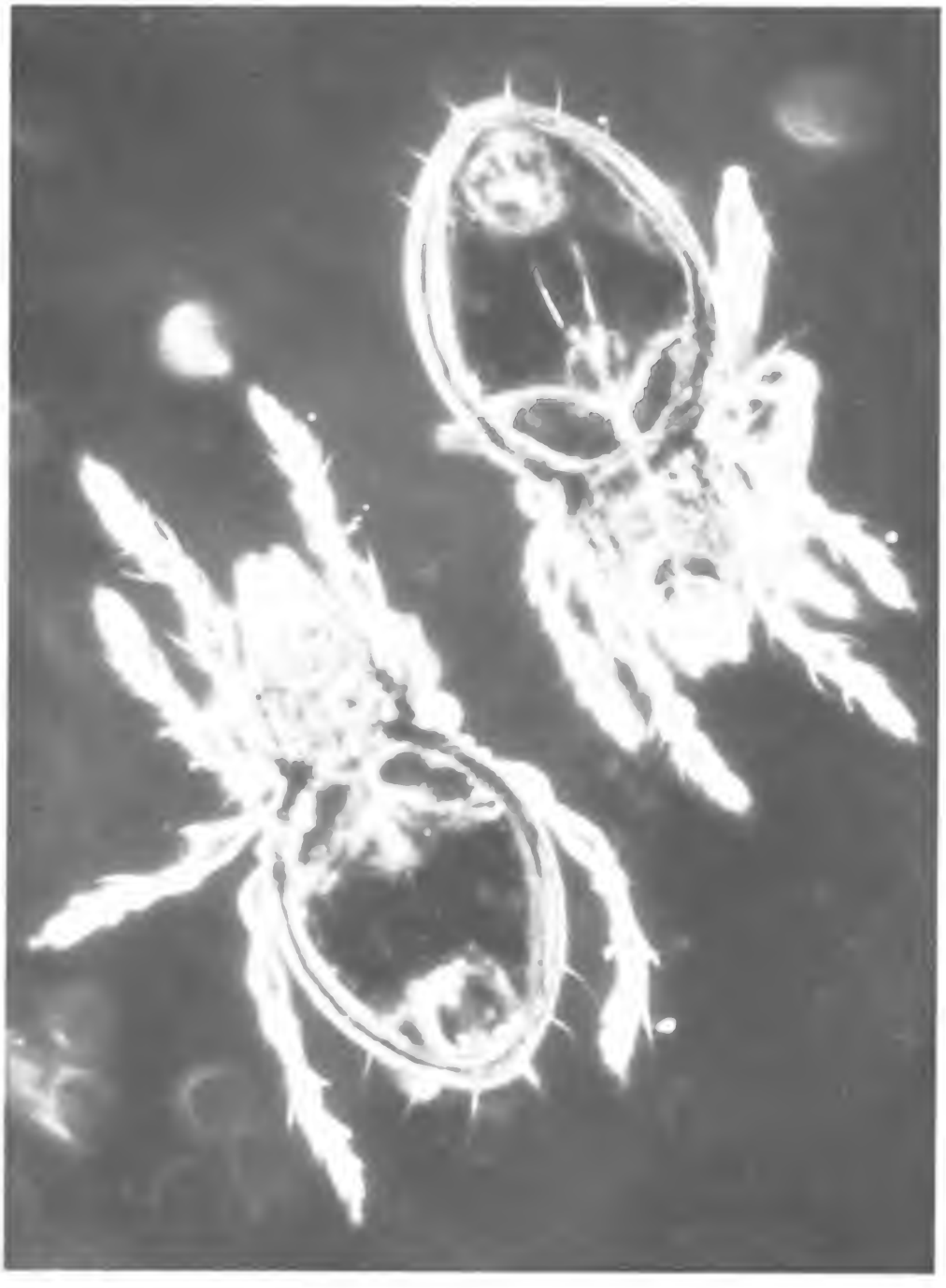

Figure 2. An oribatid mite, *Oppia clavipectinata* (Oribatei: Acarina), from a Screech Owl nest.

ARTIFICIAL NEST PLATFORMS FOR RAPTORS

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Many species of raptors will utilize artificial platforms as nest sites. Ospreys (*Pandion haliaetus*) have traditionally nested on buoys, channel markers, and other navigational aids. However, the periodic cleaning and repairing of these structures by work crews have resulted in a high number of nest failures in some areas. To reduce these unfortunate occurrences near Chesapeake Bay, in 1965, Reese (1970) erected nest platforms where they would be subject to less human interference. Some of these platforms were subsequently utilized by Ospreys. The Great Horned Owl (*Bubo virginianus*) and Red-tailed Hawk (*Buteo jamaicensis*) nested on artificial platforms in central Minnesota in 1966 (A. H. Grewe pers. comm.); similar results were reported in South Dakota (Dunstan and Harrell 1973). Dunstan and Borth (1970) found that a pair of Bald Eagles (*Haliaeetus leucocephalus*) would accept a reconstructed nest in lieu of their own, which had collapsed during a storm. In 1975, a nesting attempt on an artificial platform by Bald Eagles produced two eggs but was eventually unsuccessful. The platform had been constructed several years earlier in an area where no eagle nests had existed previously (A. H. Grewe pers. comm.). The Great Gray Owl (*Strix nebulosa*) (Nero et al. 1974) and Ferruginous Hawk (*Buteo regalis*) (White 1974) have also utilized manmade platforms. The general concepts of these types of nestings as a habitat enhancement technique have been reviewed by Olendorff and Kochert (1977) and Fyfe and Armbruster (1977).

Artificial nests have several interesting applications in raptor management. Placing them where natural nests are absent or are in poor condition can lead to their being used to expand the existing range of a species. This may be particularly important to owls since they do not construct their own nests. In central Minnesota, Great Horned Owls commonly nest on old Red-tailed Hawk nests, which are often near woodlot edges. In recent years these border areas have become favorite trails for increasing numbers of snowmobilers and cross-country skiers. Attracting owls away from these areas would reduce the number of disturbances to incubating owls, resulting in better productivity. Finally, artificial nests can be placed in trees that are accessible for study and observation. If they are well constructed, they should last several years.

I have erected a number of nests in central Minnesota and have had better success with Great Horned Owls (figure 1) than with Red-tailed Hawks. The nests were made out of 1 m x 1 m pieces of 2.5-cm-mesh chicken wire. A 1 m x 1 m piece was formed into a shallow cone by cutting from its center to one of the corners and then overlapping the edges. The completed cone measured approximately 75 cm (top diameter) by approximately 45 cm (depth); its shape was secured by bending the sharp wire ends around the wire that they overlapped. The cone was then lined with tarpaper and provided with a drainage hole at the base before nest material was added (figure 2). Unlined nests were much more susceptible to weathering. Nest material consisted of twigs, leaves, and branches, with the finer material near the top, where

the eggs would be laid. The larger branches were interwoven with each other and the chicken wire as tightly as possible to provide a solid nest structure (figure 3). When interwoven around the top edge, flexible shrubs such as willow (*Salix ssp.*) and dogwood (*Cornus stolonifera*) were effective at keeping the nest circular. The completed nest was then tied to a rope, pulled up into a tree, and secured in a suitable crotch with wire and/or large staples.

There are a number of factors that may affect the selection of artificial nests by raptors. Nests that I erected as early as the first week in January were not used by Great Horned Owls that same year. This fact seems to support the theory that Great Horned Owls select their nests several months prior to actual nesting (Baumgartner 1938). However, the chances for early selection would be improved if potential nest sites were in short supply. The height of a nest may also be a factor in its acceptance. Red-tailed Hawks generally nest near the top of the tallest available trees. The average height of 29 active natural red-tail nests that I examined in central Minnesota in 1976 was 15 m. Owls, however, will often nest lower.

In the last few years, large numbers of center-pivot irrigation systems have appeared in central Minnesota, and the clearing of fencerows and woodlots has rapidly increased to accommodate them. There also seems to be more selective cutting for firewood. In 1977 I was disappointed to find that several of the 1976 nest trees had been cut during the winter, and in one case the entire woodlot was gone! Other woodlots contained new suburban homes, constructed less than a block from recently active nests. The spread of Dutch elm disease in this area promises to eliminate still more nest trees. Rapid habitat loss such as this increases the significance of artificial nest platforms in future raptor management.

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Figure 1. Great Horned Owl in artificial nest in central Minnesota.

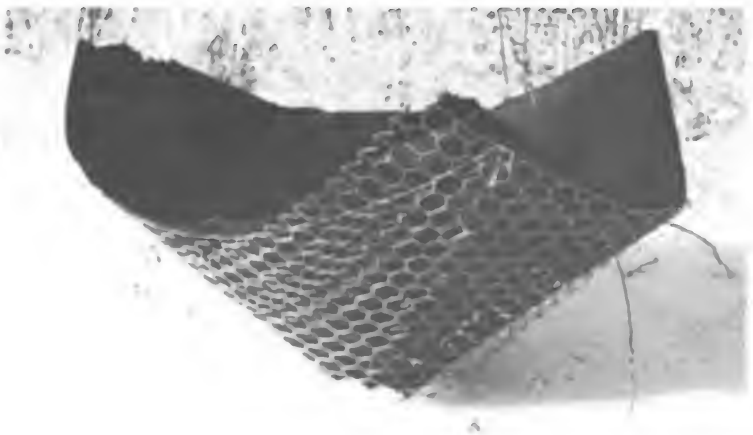

Figure 2. Artificial nest before nesting material is added, showing chicken-wire construction and tarpaper lining.

Figure 3. View of artificial nest from above showing nest material.

THE SHAPE OF THE NESTING TERRITORY IN THE NEW ZEALAND FALCON

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Introduction

The New Zealand Falcon (*Falco novaeseelandiae*), having evolved in the absence of mammalian predators, is relatively fearless and defends its nest territory more strenuously than almost any other raptor. Defensive strikes on man have been recorded for the Peregrine (*Falco peregrinus*) (Hendricks 1935, Hall 1955), the Goshawk (*Accipiter gentilis*) (Henderson 1924, Schnell 1958), the Red-shouldered Hawk (*Buteo lineatus*) (Williamson 1913, 1915), the Red-tailed Hawk (*Buteo jamaicensis*) (Fitch et al. 1946), the Osprey (*Pandion haliaetus*) (Craighead and Craighead 1937), the Bald Eagle (*Haliaeetus leucocephalus*) (C. White, pers. comm.), and the Common Buzzard (*Buteo buteo*) (William and Coan 1973, Brewster 1973); but these demonstrative attacks were the exception rather than the rule. Usually only the larger accipiters, owls and a few eagle species strike intruders with any frequency.

During visits to 31 nesting pairs of New Zealand Falcons in 1974-76, I was hit repeatedly by all nesting females and most of the males when they had eggs or nonflying young. Nest defense was also observed against the following intruders: the Australasian Harrier (*Circus approximans gouldi*), the Southern Black-backed Gull (*Larus dominicanus*) the Black Shag (*Phalacrocorax carbo*), the White-faced Heron (*Ardea novaehollandiae*), feral cats (*Felis catus*) and chamois (*Rupicapra rupicapra*), as well as men and dogs. Additionally, the falcons attacked horses and helicopters (M. Midgely, pers. comm.). Even less demonstrative species, like the Peregrine, the Gyrfalcon (*Falco rusticolus*), and the Bald Eagle (*Haliaeetus leucocephalus*) will attack helicopters (White and Sherrod 1973), which presumably are not associated with man. No intraspecific conflicts were observed, but trained New Zealand Falcons flown on occupied winter territories produced territorial defense reactions from both sexes up to 1 km from the summer nest area.

Method

One to seven visits were made to 31 nesting pairs in North Canterbury and Marlborough (South Island). The falcons were usually nesting among rocks on steep (30-40°) open or scrubby hillsides at altitudes of 300-1500 m (mean 672 m) above sea level. By approaching from different directions and on different contours and by observing aerial intruders (mainly harriers), it was possible to plot roughly the boundary of the nesting territory and, by combining the results from 31 pairs, to produce a consistent model. Although the sexes and individual pairs had differing territory sizes, especially where the ground configuration was extremely broken, the boundaries set by each individual bird were well-defined and usually consistent to within about 20 m at ground level.

Results

A generalized model of the defended nesting space, based on the 31 pairs, is shown in figure 1. The defended space included a dome-shaped area of sky over the nest site but excluded "dead" ground on the back faces of the nest ridge. Below the nest the territory rarely extended as much as 100 m. The male defended territory 200-500 m from the nest .whereas females defended only 100-400 m from the nest but were more violent.

Discussion

This model accounts for observations of strong nest defense in places other than the nest (usually the opposite side of the gully) experienced by me and by other observers in other species (Brown and Amadon 1968:92), and for the common observation that falcons are more sensitive to disturbance from above (Herbert and Herbert 1965, Nelson 1973) than from below. The model is also similar to Cade's diagram of two-dimensional Peregrine territories (1960:199). The only observations to the contrary were made by Beebe (1960:165), who considered that the marine Peale's Peregrines off the British Columbia coast were more sensitive to disturbance from below than from above. Possibly Beebe was observing a conditiond reaction to a frequent unidirectional stimulus, boats being the main method of transport in that area. I have no data for falcons nesting on flat terrain.

Acknowledgments

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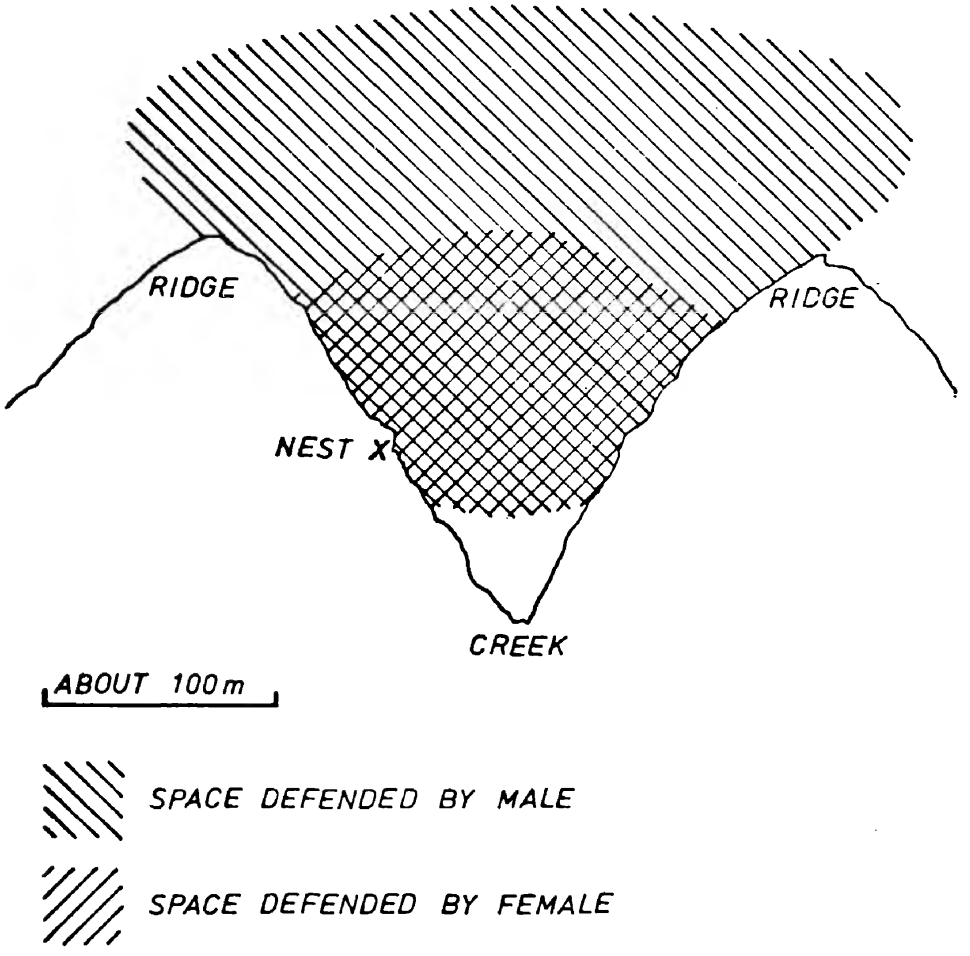

Figure 1A

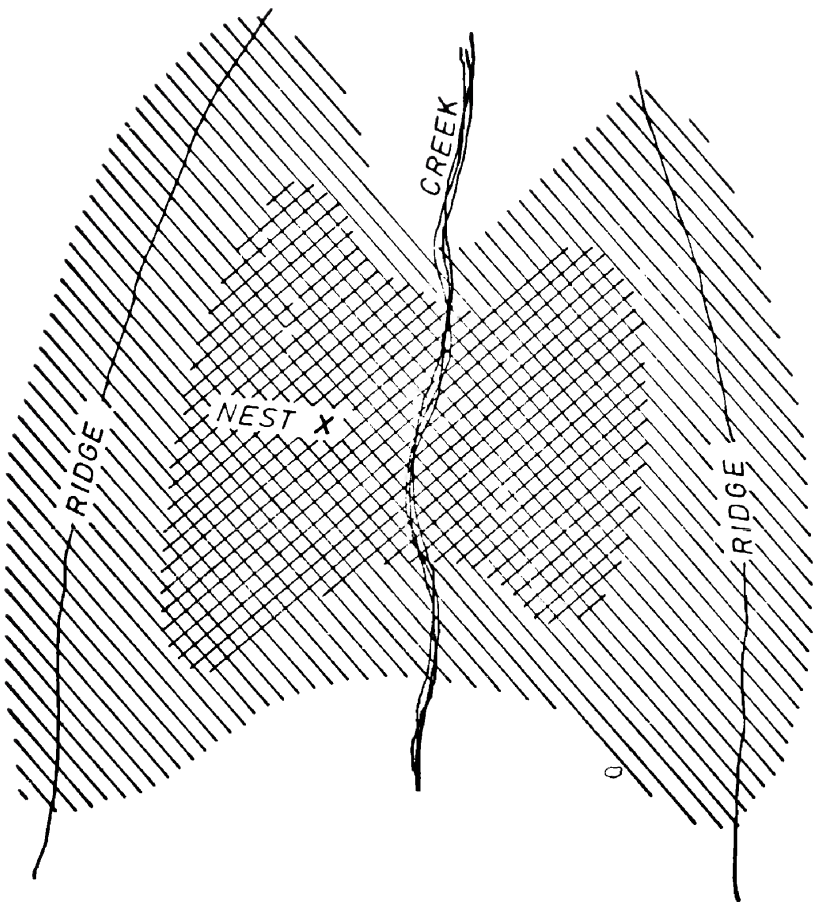

Figure 1B

Figure 1. A model of the nesting territory defended by a pair of New Zealand Falcons based on observations of 31 breeding pairs. A: Transverse of the defended space. B: The defended space viewed from above.

SEROLOGICAL INVESTIGATION OF CAPTIVE AND FREE LIVING RAPTORS

by
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Abstract

Interest in the role of raptors in zoonotic diseases and concern over the disease agents that can be introduced into raptor colonies by birds from the wild prompted a serological investigation of birds available to the University of California at Davis. Seventy-one raptors of 14 species were tested for antibodies against two or more of the following disease agents: *Toxoplasma gondii, Coxiella burnetii* (Q Fever), Newcastle disease virus, adenovirus, reovirus, and infectious bursal disease virus. The techniques used included the indirect hemagglutination, microagglutination, hemagglutination ihibition, and agar gel precipitin tests. Collectively, 30% (21/71) of the birds were seropositive for Q fever rickettseae antibodies, 8% (6/71) were seropositive for *Toxoplasma* antibodies, and one of 70 had antibodies against infectious bursal disease virus. Antibodies against Newcastle disease virus, adenovirus or reovirus were not detected. The species of raptors that had antibodies against toxoplasmosis were Red-tailed Hawk (Buteo jamaicensis) 23% (3/13), Red-shouldered Hawk (*Buteo lineatus*) (1/1), Great Horned Owl (*Bubo virgiianus*) (1/10), and Turkey Vultures (*Cathartes aura*) (1/14). The raptors seropositive for *C. burnetii* were Golden Eagle (*Aquila chrysaetos*) 100% (6/6), Red-tailed Hawk 69% (9/13), Vultures 29% (4/14), Harris' Hawk (*Parabuteo unicurctus*) 14% (1/7) and Great Horned Owl 10% (1/10). A Red-tailed Hawk was seropositive for infectious bursal disease virus.

Introduction

Each year thousands of hawks, eagles, and owls are injured in accidents or shot by careless or ignorant hunters (Snelling 1975, Wisecarver and Bogue 1974, Fuller et al. 1974). Of these the vast majority are left to die; however, a few are taken to raptor centers or veterinary hospitals where they can be treated. While the loss of a wing or a foot predisposes the birds to a life of captivity, others recover from their injuries. These few are reeducated to forage for their food and are released into the wild.

Since raptors are protected by the migratory bird treaty, they are usually unavailable for the study of infectious diseases. Consequently, little is known about their exposures to agents responsible for zoonotic diseases or diseases common to domestic birds. These disease agents include such entities as *Tosoplasma gondii, Coxiella burnetti,* Newcastle disease virus, avian adenovirus, reovirus and infectious bursal disease virus. A brief description and reason for our interest in these infections of wild birds follows:

Toxoplasma gondii is the protozoan organism that causes toxoplasmosis in a wide variety of birds and mammals. Wild and domestic birds frequently harbor *T. gondii* cysts in their body tissues with no clinical evidence of illness; however, deaths among captive exotic birds and illnesses in domestic fowl have been reported (Ratcliff and Worth 1951, Jacobs and Melton 1966). Birds of prey are of special interest since *T. gondii* can be transferred through carnivores feeding on infected animals.

Coxiella burnetii is the rickettsia responsible for Q fever in man. While infection does not appear to cause clinical illness in birds, the organism can invade and persist in spleen and kidney tissues where it can serve as a source of infection (Bell 1971).

Newcastle disease is a contagious viral disease, primarily of avian species, but it can also cause conjunctivitis in man. The pathogenicity of the agent in birds depends upon the characteristics of the virus strain, and infections can range from minor to fatal. Lesions observed in wild bird species include exudative airsacculitis, petechial hemorrhages in the epicardium, enlarged liver, and catarrhal pneumonia (Palmer and Trainer 1971). However, recent reports of Newcastle disease in birds of prey indicate that gross pathological changes tend to be slight, variable, and nonspecific (Chu et al. 1976). The disease is highly infectious and can be transmitted via exudates, excreta, and eggs. Wild birds may harbor the virus for 30 days or more and are therefore capable of introducing the disease into raptor centers or among domestic poultry.

Avian adenovirus. Since its initial isolation from Bobwhite Quail in 1949 (Olson 1950), avian adenovirus has been implicated in diseases of chickens, turkeys, and captive game birds (Blalock et al. 1975, Dubose 1972, Fadly and Winterfield 1973).

Adenovirus has been the reported cause of a variety of clinical syndromes including fatal respiratory disease of Bobwhite Quail, inclusion body hepatitis of chickens, hemorrhagic enteritis of turkeys, and marble spleen disease of pheasants (Bickford 1974, Lini et al. 1973, Olson 1950; Winterfield et al. 1973). Also miscellaneous syndromes such as mild respiratory disease, egg production declines, and egg-shell-quality problems in chickens and turkeys have been described. Although recent evidence suggests that inapparent adenovirus infections are very common in domestic fowl (Boyle 1973, Cook 1970, Green et al. 1976, McMillan 1976), there is very little known about its potential pathogenicity in other avian species.

Avian reovirus. The reoviruses are common animal viruses, having been isolated from the feces and respiratory tracts of man and a variety of domestic and wild animals, including chimpanzees, monkeys, cattle, dogs, (Deshmukh and Pomeroy 1969, Lou and Wenner 1963), mice and birds (Macrae 1962, Rosen 1962). The avian reoviruses are ubiquitous among poultry populations and have been reported to cause cloacal pasting in young chicks, respiratory infections in chickens, enteritis in turkeys, and viral arthritis in chickens (Olson 1975). The incidence and effects of reovirus infections in other avian species are unknown.

Infectious bursal disease virus. IBDV causes an acute disease in susceptible 3- to 6-

week-old chickens, characterized by severe depression, ruffled feathers, trembling, and incoordination (Cosgrove 1962). Infection of susceptible chickens less than 2 weeks of age is usually inapparent (Hitchner 1971) but results in immunosuppression (Cho 1970), leaving affected birds more susceptible to other diseases (Faragher et al. 1972; Faragher, Allan et al. 1972, Wyeth 1975). The incidence and effects of IBDV infection in other avian species are unknown.

This report deals with serotesting of wild birds that were sampled in the wild or were brought to the Veterinary Medical Teaching Hospital (VMTH) for treatment or were maintained at the Raptor Center at the University of California, Davis.

Materials and Methods

Birds. A total of 71 raptors of 14 species were serotested. Sixteen of the birds were blood sampled during their initial examination upon admittance to the VMTH for treatment. Most of them were admitted for gunshot wounds of the wing. Thirty-two of the birds were from among the 200 being maintained at the UCD Raptor Center. They are birds that have been permanently impaired and are unable to survive in the wild or that have recovered from their injuries and are being retrained for release. The birds are fed newly hatched chickens and laboratory mice.

The vultures were captured in the wild in cooperation with the Deparment of Fish and Game. The serum samples were originally collected for the testing of antibodies against botulinum toxins (Ohishi et al. 1977). The remaining serum samples were submitted by persons licensed to raise raptors.

Most of the birds originated from central California with a few from as far south as Santa Cruz County or as far north as Butte County. The birds ranged from less than one to eleven years of age, and others of unknown age had been in captivity since 1974.

Serology. From 0.5 to 2.0 ml of blood was drawn from the wing vein using a 3 ml syringe and 25 g needle. The blood vial was laid on its side to maximize the clotting surface of the blood and increase the serum yielded. The serum was transferred to small vials and kept frozen until tested. Not all tests were done on each sample because of insufficient quantity.

The indirect hemagglutination (IHA) test was used to examine the sera for antibodies against *T. gondii.* One drop (0.025 ml) of serum was added to the first well of a microtiter plate, and doubling dilutions of serum from 1:2 to 1:4096 were made. The serum was tested at 1:64 using commercially available antigen.[1] An agglutination reaction of 2+ was considered positive, and the serum was tested to the end point. The 1:32 serum dilution was used for the nonsensitized cell control.

The 1:2 to 1:16 serum dilution was tested for antibodies against *C. burnetti* using the microagglutination (MA) method (Fiset et al. 1969). The antigen prepared from Nine Mile strain of *C. burnetti* in phase I was grown in the yolk sac of embryonated hens' eggs. The antigen was transformed from phase I to phase II activity using trichloracetic acid and stained with hematoxylin.

The serum was tested for antibodies against Newcastle disease virus by the micro hemagglutination inhibition test (HI) (Lancaster 1966). Eight units of viral suspension and 0.05 ml of a chicken red blood cell suspension were used.

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[1]International Biological Laboratories Inc., P.O. Box 1247, Rockville, Maryland 20850.

Avian adenovirus antigen was prepared in specific pathogen-free (SPF) embryonating eggs by CAM inoculation with the CELO adenovirus strain (Woernle 1966, Yates 1975). Chicken sera from an adenovirus-antibody-positive flock were pooled and used as a positive control.

Avian reovirus antigen was prepared in chicken embryo kidney (CEK) cells (Olson 1975). Positive control sera was obtained from hyperimmunized 8-week-old SPF chickens.

Infectious bursal disease virus was propagated in three-week-old SPF chickens (Hirai and Shimakura 1972) via intranasal inoculation. The infected bursea were harvested, homogenized, and centrifuged, with the resulting supernate used as IBDV antigen. Positive control sera was obtained from hyperimmunized eight-week-old SPF chickens.

Agar gel precipitin plates (Miles Laboratories) were prepared, using 1.25% agarose (Sigma Chemical Co.) in barbital buffer (pH 7.8) with 8.0% NaCl and 0.01% sodium azide. Antigen was placed in the center well of a 6-well cluster, with 2 positive control sera. The plates were tightly covered and incubated overnight at room temperature then were examined in indirect light.

Results

Of the 71 birds tested, 6 (8%) were seropositive to toxoplasmosis, 21 (30%) had agglutinating antibodies against the Q fever rickettsiae, and one of 70 was reactive for antibodies to IBDV. None of the birds tested were seropositive for Newcastle disease virus, adenovirus or reovirus (table 1).

The highest prevalence of antibodies against *T. gondii* (23%) was among Red-tailed Hawks. The prevalence among the Red-shouldered Hawks is probably similar, but too few of the species were tested to estimate with certainty. In all cases the birds tested had low titers that did not exceed 1:64.

The antibody prevalence for *C. burnetii* was high among Golden Eagles (100%) Red-tailed Hawks (69%), and vultures (29%) (table 1). The median antibody titer for eagles and Vultures was 1:4 whereas the median titers among Red-tailed Hawks was 1:8 with two hawks having titers $\geq$ 1:16.

Discussion

In a recent survey, serological evidence of exposure to *T. gondii* was found among 3.5% of 401 wild birds that were tested (Franti et al. 1976). The prevalence of this parasite among raptors appears to be more than twice that of nonraptors, probably reflecting the raptor habit of feeding on small rodents. Since the prevalence of *T. gondii* is approximately 2% among the species of rodents that raptors commonly feed upon, this mode of exposure seems likely in view of the large number of rodents consumed by these species of birds. Birds are probably an important intermediate host for *T. gondii* in nature since they are a primary food source for wild carnivores, including bobcats, a definitive host of this parasite.

Previous surveys of antibodies against *C. burnetii* among wild birds in association with livestock indicated a prevalence of 13% among birds on a sheep range and 38% among birds on a dairy farm (Enright, Longhurst et al. 1971). The highest prevalence (33% to 67%) was among species of birds that ate carrion (crows, ravens, and turkey vultures). Raptors tested here also appeared to be exposed to *C. burnetii* because of their feeding habits. Approximately 5% of the seed-eating birds and from 2% to 31%

of the small mammals and rodents that are a food supply of raptoral birds have serological evidence of being infected with *C. burnetii* (Enright, Franti et al. 1971).

The significance of individual antibody titers is obscure because little is known concerning zoonotic diseases of raptors. If raptors respond to *C. burnetii* infection the way mammals do, the following should apply: agglutinating antibodies are detectable

Table 1. Raptors Tested for Antibodies Against Various Diseases

Scientific Name	Common Name	Toxoplasmosis	Q Fever	Newcastle disease	Adenovirus	Reovirus	Infectious bursal disease
Cathartidae							
Catartes aura	Turkey Vulture	1/14*	4/14	ND	0/14	0/14	0/14
Elaninae							
Elanus leucurus	White-tailed Kite	0/3	0/3	0/3	0/3	0/3	0/3
Accipitrinae							
Accipiter cooperii	Cooper's Hawk	0/1	0/1	0/1	0/1	0/1	0/1
Buteoninae							
Buteo jamaicensis	Red-tailed Hawk	3/13	9/13	0/11	0/11	0/11	1/12
Buteo lineatus	Red-shouldered Hawk	1/1	0/1	0/1	0/1	0/1	0/1
Buteo regalis	Ferruginous Hawk	0/1	0/1	0/1	0/1	0/1	0/1
Parabuteo unicinctus	Harris' Hawk	0/7	1/7	ND	0/7	0/7	0/7
Aquilia chrysaetos	Golden Eagle	0/6	6/6	0/6	0/6	0/5	0/6
Circinae							
Circus cyaneus	Marsh Hawk	0/2	0/2	0/2	0/2	0/1	0/2
Falconineae							
Falco mexicanus	Prairie Falcon	0/2	0/2	0/2	0/2	0/2	0/2
Falco sparverius	American Kestrel	0/3	0/3	0/3	0/3	0/2	0/3
Tytonidae							
Tyto alba	Barn Owl	0/7	0/7	0/7	0/7	0/7	0/7
Strigidae							
Otus asio	Screech Owl	0/1	0/1	0/1	0/1	0/1	0/1
Bubo virginianus	Great Horned Owl	1/10	1/10	0/10	0/9	0/9	0/10
Totals		6/71	21/71	0/48	0/68	0/64	1/70
Percent Positive		8	30	0	0	0	1

*Number positive / number tested
ND Not done

by 10 days after the host is infected. the antibody response reaches a peak by 20 days and begins to decline slowly thereafter (Fiset and Ormsbee 1968). Therefore, the low titers found among birds in this study probably reflect long past exposures. However, since both *C. burnetii* and *T. gondii* can cause chronic infections, the organisms can sometimes be recovered from hosts with little or no antibody titer.

Newcastle disease among raptors appears to be sporadic and is often linked with birds in captivity that are fed carcasses of dead poultry or game birds. Since Newcastle disease appears to have an affinity for colonial birds that frequent the environment of commercial flocks, the disease may be much less common among solitary living raptors. Nevertheless, surveillance and possibly a vaccination program should be maintained to guard against introducing the disease into raptor centers.

Interpretation of nonreactive agar gel precipitin (AGP) tests requires some caution. Precipitin antibody of low serum concentration may not be detected because of the relative insensitivity of the AGP test. Also, the AGP test may not detect virus-neutralizing antibodies. However, on the basis of previous experience with similar serologic surveys, the results reported here indicate that there probably have not been recent infections with any of the test viruses. The one exception was a single weakly positive reactor to IBDV. A larger sample size or experimental susceptibility tests would be necessary to assess the significance of this observation. However, this positive reaction suggests that raptors may be susceptible to IBDV infection.

The agar gel precipitin test has proved to be a valuable surveillance and diagnostic aid in the health management of domestic poultry. Its potential importance in the health management of captive avian species increases as more birds are placed in rehabilitation and breeding facilities. This simple test can be used to produce a serologic profile of existing captive birds, to screen new arrivals for inapparent infections, or to aid in the diagnosis of a disease outbreak. The AGP test could also be used to evaluate the effectiveness of vaccination programs in cases where experimental challenge of birds is unwarranted. A battery of AGP tests for potential pathogens including Newcastle disease virus, avian pox, and herpesvirus would provide valuable information for the health management of captive birds of prey.

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ANNOUNCEMENT

THE HAWK TRUST

Readers of *Raptor Research* may know relatively little about the work and aims of the Hawk Trust. It is hoped, in this and subsequent issues, to report some of the trust's activities.

The Hawk Trust is a British charitable organization which is concerned at the downward trend of many of our raptor populations. The aims of the trust are to carry out research into bird of prey breeding, ecology, and treatment of disease, as well as providing wardens at vulnerable breeding sites of rare species in conjunction with other conservation bodies.

A particularly successful event organized by the trust in 1977 was its Open Day on October 8. Despite very wet weather, nearly 100 people attended, amongst them several overseas visitors who had earlier been at the Oxford Conference. In addition to seeing the aviaries and learning something about the trust's work, the visitors were

able to hear lectures by Dr. Patrick Redig on work with sick raptors and Dr. Joseph Platt on his falcon-breeding project in Bahrain.

A full time research fellow, James Kirkwood, B.V.Sc., M.R.C.V.S., has recently started work at the trust and will be studying the nutrition of birds of prey using captive birds from the Hawk Trust's aviaries. The study will concentrate upon the food requirements of the European Kestrel (*Falco tinnunculus*), including the food intake of the young from hatching and the food increment required for egg-laying.

Other projects currently in progress by part-time workers include research into the behavioral and physical ontogeny of raptors and investigations into the hematology and blood parasites of birds in the trust's collection.

Further information on these projects and other aspects of the trust's work may be obtained from The Hawk Trust, P.O. Box 1, Hungerford, Berkshire, England.

J. E. COOPER

HAWK MOUNTAIN RESEARCH AWARD

The winner of the first annual Hawk Mountain Research Award was James C. Bednarz of Iowa State University for his studies of the "Status and habitat utilization of the Red-shouldered hawk in Iowa."

The Board of Directors of Hawk Mountain Sanctuary Association announces its second annual award of $250 for support of raptor research. The Hawk Mountain Research Award is granted annually to a student engaged in research on raptors (Falconiformes).

To apply, students should submit a description of their research program, a curriculum vitae, and two letters of recommendation by October 31, 1978 to:

Mr. Alex Nagy
Hawk Mountain Sanctuary Association
Route 2, Kempton, Pennsylvania
19529

A final decision will be made by the Board of Directors in February 1979.

Only students enrolled in a degree granting institution are eligible. Both undergraduate and graduate students are invited to apply. Projects will be judged competitively on the basis of their potential contribution to improved unerstanding of raptor biology and their ultimate relevance to conservation of North American hawk populations.

THE RAPTOR RESEARCH FOUNDATION, INC.

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